REMARKS

Prior to this preliminary amendment, claims 1-24 were pending in this application. New claims 25-38 have been added to define the invention more clearly. The new claims have been drafted with terms of such scope as Applicant is believed to be entitled. Consideration of these claims, with claims 1-24 originally filed, is respectfully requested.

The specification has been amended to correct numerous typographical errors.

Respectfully submitted,

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ATTACHMENT FOR SPECIFICATION AMENDMENT
VERSION WITH MARKINGS TO SHOW CHANGES MADE
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The following was substituted for the paragraph beginning on page 4, line 14:

Since the traditional ground stations are generally located in remote, sparsely populated areas, taking advantage of commercially financed, installed, and maintained fiber optic networks is unlikely since there is no financial motivation for servicing such geographic (polar) areas. This means communication from traditional ground stations to the processing center (probably in the U.S.) is expensive for the data rates (bandwidth) needed by future weather satellites. Either dedicated, sole-user fiber is needed, or perhaps a complex, risky, and expensive "hop" from the station to a communications satellite and back to the U.S. is needed. Or, a slow existing link might be used, but because of limited bandwidth, data will again be delayed awaiting [it's] <u>its</u> turn in a rate buffer queue for ground communication.

The following was substituted for the paragraphs beginning on page 8, line 13 and ending on page 14:

["Autonomous Mode"] <u>*Autonomous Mode*:</u> An alternative embodiment where the system is completely autonomous, yet with coverage immunity to failures. Improvements and repairs still can be made on the ground only.

["Traditional Ground Stations"] <u>*Traditional Ground Stations*:</u> In the context of this specification, this refers to large, complex, expensive, facilities used for many years in the past to support communications with various satellite systems.

["Receptor"] <u>*Receptor*:</u> The preferred embodiment may use, for example, a distributed network of small extremely simple, and relatively inexpensive, unmanned

antenna/receivers that are receive-only. (Downlink signal reception, but no uplink signals sent to the satellite(s)). These are technically earth stations, but of a significantly reduced complexity/cost class than the Traditional Ground Stations noted above.

["Checksum"] *Checksum*: This is one of several mathematical means of verifying the integrity of a block of digital data, of varying potency. For simplicity in describing the preferred embodiment, checksum will be referred to, but any of the several other, possibly more complex and robust methods may be used for a specific application. A checksum is simply the sum of all values in a known-size dataset. If a subsequent checksum is done on the same dataset at a later time (say, after communication transmission) and [it's] its checksum value isn't precisely the same as the original checksum for the same dataset, errors in the dataset are present. Checksum does not allow correction of errors, but merely is a test (only) for data integrity. The important point is that the amount of bits needed for a checksum value (or other integrity-test-only method) is extremely small compared to the amount of bits in the dataset itself.

["Virtual Spherical Coverage"] *Virtual Spherical Coverage*: A feature whereby the whole earth can be mapped in a timely and confident (high data integrity) manner, despite having intermittent communication contact (satellite-to-ground downlinking) of less than four PI steradians (spherical coverage).

["Mission Data"] *Mission Date*: The actual useful information from a satellite, such as imagery produced from mission instruments, plus any overhead needed such as headers and encryption. (Other data from a satellite typically includes things such as

satellite housekeeping information, which is typically very low data rate in comparison to the actual end-use mission data.)

["Data Timeliness"] *Data Timeliness*: The time from when data was collected, to when it becomes useful to the end-user. In systems such as the example mission cited below when configured as a legacy system using traditional ground stations, the dominant timeliness constituent is the delay between downlink contacts from the physical constraints of orbit and ground station geometries. Also referred to as data aging or data latency.

["Preemption"] *Preemption*: For one of several possible reasons, a geometrically possible communication opportunity (satellite is within nominal communication range and adequate other conditions) is not utilized for downlinking mission data. Examples of preemption include: 1) ground station is preoccupied servicing another satellite having higher communication priority, 2) a ground station is down (inoperable) due to scheduled maintenance or unscheduled failure of [it's] its own equipment or [it's] its communication to the final data delivery point (e.g. ground communication to the U.S.), 3) ground station staff insufficient, 4) severe weather at a ground station (e.g. extreme wind requiring antennas to be caged), 5) RF interference avoidance with another component.

"[Blind Orbit"] *Blind Orbit*: An orbit where a satellite has had no opportunity to pass (downlink) Mission Data because of either a geometrically impossible situation (no ground stations within communication range on that orbit), or all communication opportunities were preempted. This is a very undesirable situation for missions where

data timeliness is important, since onboard stored mission data will include an additional whole orbit's worth of delay by the time it is finally downloaded.

["LEO, MEO, and GEO"] *LEO, MEO and GEO*: Grouping general classes of Earth orbiting satellites by their gross altitude.

[LEO:] *LEO*: Low Earth Orbit (in the hundreds of kilometers altitude range).

[MEO:] *MEO*: Medium Earth Orbit (in the thousands of kilometers altitude range).

[GEO:] *GEO*: Geosynchronous Earth Orbit (an altitude of around 36,000 kilometers, if circular, resulting in the satellite having an orbital period the same as Earth's rotation (one day), causing it to appear stationary overhead to an observer at a fixed location on Earth[.]).

["Sun-Synchronous-Polar-Orbit"] *Sun-Synchronous-Polar-Orbit:* At certain circular orbit altitudes and associated inclinations (e.g. around 800 Km and a few degrees of inclination) a satellite's orbit plane follows the Sun-Earth annual cyclic vector angular motion in inertial space. Such an orbit is advantageous to missions, such as the weather satellite mission. This orbit results in the entire Earth being mapped in a relatively short time at desirable constant sun illumination angles, owing to the combined dynamic geometry of the Earth's daily rotation, plus orbital motion, plus the cross-track swath of the satellite sensor's field-of-view. For global weather observation from relatively low altitudes (e.g. LEO versus GEO), this is an ideal scenario: full spherical coverage from consistent observation angles updated fairly frequently.

["SSR" Solid State Recorder] *Solid State Recorder (SSR):* Recently satellites have been implementing onboard data storage with solid state recorders, in lieu of earlier

data storage implementations such as mechanical tape recorders. SSRs are essentially large amounts of RAM (as in a computer) plus some controlling circuitry. Obviously the elimination of moving parts (which eventually wear out and are prone to failure) is a reliability advantage. More importantly for system 10 is the random addressing capability (the "R" in RAM), programmability, and asynchronous operation, as will be shown.

["Code and Coding"] _Code and Coding:_ Two disparate uses: 1) Code referring to computer program instructions, and 2) Coding referring to data overhead for error detection/correction algorithms.

["Satellite Operations Center"] _Satellite Operations Center:_ Usually a single facility for controlling satellites. Here commands are sent to the satellite to specify [it's] its operation.

["Processing Center"] _Processing Center:_ Where mission data arrives to be converted to useful information for the intended end use. For instance, in connection with the preferred embodiment, weather maps are produced by analyzing (via computer) multi-spectral imagery data collected by the satellite with algorithms that can convert that raw data to a useful end product format.

The following was substituted for the paragraph beginning on page 23, line 8:

Referring to Figure 1, Mission Data collection is achieved in a conventional manner by satellites 20 and 22. Sensors 27 and 28 continuously observe the Earth and [it's] <u>its</u> atmosphere producing a continuous stream of data. Onboard electronics then condition the data, multiplexing various data sources, compressing, encrypting, and

other common data formatting operations. (As noted above, the data rate for convenient illustration here is assumed at a constant rate, but could also be variable.)

The following was substituted for the paragraph beginning on page 23, line 17:

In satellite 20, data is routed to two destinations: the first to the SSR 24 (Figure 2) for continuous onboard storage, and the second to a multiplexer at the medium data rate broadcast downlink transmitter. At the multiplexer it is always[_] continually broadcast in real time as data is collected[ ]. At the SSR destination it is also always continuously stored incrementally in time (sequence).

The following was substituted for the paragraph beginning on page 24, line 21:

So, system 10 asserts that [it's] <u>its</u> anticipated transmissions to expected active contacts will be successfully received by receptors, such as A-C, and forwards the transmissions to processing center PC, open loop, according to [it's] <u>its</u> onboard contact availability map. When a gap in coverage is indicated by the map, that data (being continuously stored in the ring buffer 24) is marked for later transmittal, is retrieved from the SSR 24 and is multiplexed along with the continuously transmitted real time data. The system 10 is anticipatory: it downlinks saved gap data when the satellite is confident it will successfully be received. (If that fails, the data will still be retrieved at the next opportunity once the missing data is reported.)

The following was substituted for the paragraph that begins on page 25, line 12:

Referring to Figure 4, if for some reason a segment of that open loop data never makes it successfully to the processing center PC when anticipated, it can be requested for retransmission (automatically) by the SOC 100 logic. Such a request would occur,

for example, if a receptor was physically damaged in a storm, or lost [it's] its source of electrical power. The coverage map is then updated for future use with that receptor removed and uplinked at the next opportunity to the satellite to correct [it's] its future contact profile assertions. (The center 100 has the same coverage map and knows when data should arrive.) Note that even though the system 10 is nominally a very simple open loop arrangement, it can retrieve missing or noisy data segments well within a reasonable delay time.

The following was substituted for the paragraph that begins on page 26, line 3:

A traditional system, always has forced substantial delay since contact opportunities are widely spaced. If a traditional expected ground station contact is missed, serious excess latency results, rendering the data essentially useless for dynamic weather use. Thus, a traditional system critically needs and relies on every one of [it's] its infrequent downlink opportunities, whereas the system 10 recovers quickly and is immune to data tardiness if a receptor pass is missed.

The following was substituted for the paragraph beginning on page 26, line 12:

Another embodiment ("Autonomous") is possible. For some applications, the alternative may be a potential additional but possibly acceptable burden on downlink channel use. It is akin to the patents referenced in the background section. The satellite would continuously broadcast time-shifted data copies from earlier periods in [it's] its orbit, in a post facto fashion. For example, if, say, four layers of time shifted data were continually broadcast assertively (open loop) to receptors having typically a ten minute pass, about a quarter of an orbit's prior data could be received automatically by a single receptor in that vicinity. As is described in the reference patents, a similar

technique for increased downlink and ground communications would be to reduce the quality (lossy compression) or to partially select critical data sections, and thus reduce the data rate of the redundantly transmitted layers. Data would still get to the destination in a timely and complete manner, but with a slightly reduced fidelity. This totally open loop, virtual spherical coverage mode could be a backup, fail safe modality. If the satellite is for any of several reasons not receiving a normal uplink command profile, the satellite could automatically default and reconfigure to this totally autonomous mode. This would still provide full Earth coverage, even if receptors randomly fail. In other words, the system is completely automated, and any repairs needed for continuous coverage are made on the ground (e.g., repairing inoperable receptors or supplementing them with nearby additional receptors[,]).

The following was substituted for the paragraph beginning on page 28, line 7:

System 10 automatically recognizes and adjusts the coverage map when a new receptor is brought on line. There is no need to tell the system it has been added and to look for it. Also note that receptor deployment and installation is remarkably easy: a contracted local technician simply unpacks the unit (in maybe two or three convenient pieces), secures the receptor stanchion in approximately the appropriate North/South orientation (via a magnetic compass or handheld GPS unit), and squares it vertically with a bubble level. Once power is provided and network communication (fiber optics connection) is established by conventional commercial methods, installation is complete. This crude initial orientation is adequate, since the receptor is initially commanded in a simple search pattern remotely from the operations center, pointing the receptor antenna generally in the direction at the right time when a known system

10 satellite will over fly. Since the system 10 satellites are continuously transmitting real time data, no coordination or cooperation is necessary. The processing center PC will suddenly start receiving valid data from the new receptor and adjust the common coverage map accordingly. Any receptor misalignment is dialed in as a bias to [it's] its future pointing commands from the operations center. Since the satellite (instant) location is very accurately known from [it's] its orbital elements, and the location of a receptor is also accurately known and fixed (via a onetime GPS handheld measurement), the precise pointing locii for all satellite/receptor dynamic combinations is easily and accurately calculated. There is no need for constant "hunting" and handshaking for acquisition. The receptor is simply told where and when to point, and passes along whatever it receives.

The following was substituted for the paragraphs beginning on page 29, line 16 and ending on page 31:

At least three means of insuring data integrity (successful and complete data receipt) are available and implemented in system 10:

(1) Traditional error detection/correction overhead bits embedded in the data stream right on the satellite. (The usual digital communications procedure).

(2) By comparing a delayed (time-shifted) "checksum" (etc.) stream of each original data packet (embedded in the downlink stream, before receptor receipt and passage to the processing center) with a checksum calculated for packets as they arrive at the processing center. According to the preferred embodiment, every so often, the checksums of all previous packets collected in an orbit are sent as a burst along with the real time mission data. (This is a trivial impact on overall transmitted data rate,

thus costing nothing in bandwidth.) So, when the processing center PC receives mission data, it also gets the checksums of all data sent for 100 minutes prior to that time. These delayed spacecraft-calculated checksums can be compared to checksums calculated again by the [EPC] PC on the same data received after transmission. If there is a difference, then the suspect data can be requested for retransmission via the next command opportunity, since it is still resident and intact in the satellite SSR 24. This alleviates a remote but possible situation, of particular concern for military uses, of weather data tampering. Imagine someone clever enough to intercept and alter data en route from a receptor to the processing center. (Practically speaking an essentially impossible, yet remotely conceivable task, since the data is probably compressed, encrypted, and laced with several layers of data quality tests and error correction means.) So, if the seemingly impossible tampering were successfully accomplished, say, to make it look like rain in Spain when in fact it is a sunny day, the act would be detected within minutes. (The next receptor downlink checksums wouldn't match). Future reception from a tampered receptor's data would of course be suspect, and disregarded until the problem has been removed.

The following was substituted for the paragraph beginning on page 31, line 19:

(3) System 10 also provides for satellite command intrusion immunity. A valid concern is the potential of a renegade individual or group sending unauthorized commands to a spacecraft for whatever reason. As such, traditional ground stations are highly secured to alleviate the possibility of intrusion. The system 10, however, preferably is a downlink-only system. It is impossible to tamper with a receptor and send erroneous commands to a satellite, since there is no physical mechanism

(transmitter and associated feed and logic and modulation electronics). Thus, the concern of locating receptors in questionable areas is not of concern for sending false commands to the satellite(s).

The following was substituted for the paragraph beginning on page 37, line 8:

16) No concern about simultaneous downloads to same terminal (physically [can't] impossible);

The following was substituted for the paragraph beginning on page 37, line 10:

17) Simple deployment and installation[ ];

The following was substituted for the paragraph beginning on page 37, line 11:

18) An excellent approach to system autonomy ([ ]Autonomous Mode).